

XVII.—A NOTE ON THE TRANSMISSION OF MALARIA AT  
KETTI, NILGIRIS, 6,300 feet.

Towards the end of September, 1941, there occurred at St. George's, Ketti, what Dr. Russell, then attached to the Malarial Institute of India, described as 'an unique outbreak of malaria'. Out of the 235 children in the school there were seven cases of malaria (blood smears showing *P. falciparum* 5, *P. vivax* 3, one showing both species).

In early June of 1936 two other cases had occurred among the children and at the same season this year a member of my staff contracted the disease (all blood smears showing *P. vivax*).

In the October epidemic the possibility of relapses must be considered in four cases, as three of the children had originally, but not recently, come from the plains. None of them, however, had been out of Ketti since February, and the fourth child had on one occasion been down to the jungles at Kallar, though only for a short time during the day. The remaining children had been living in Ketti for some years, one of them never having been away from the hills<sup>1</sup>, and the rest not having descended below 6,000 ft. during their residence in Ketti.

Regarding the cases of 1936, both the children had lived in Ketti for a considerable period: one had not been below 6,000 feet for several years, but the other may have returned to his home on the plains for the Christmas holidays, so must be considered as a possible relapse. In the case recorded in this year the patient had spent part of January in Madras. Malaria was possibly contracted there as the patient had not been near the streams and marshes mentioned below and also had been well bitten by mosquitoes in Madras, a focal point of infection being the presence in the neighbourhood of evacuees from Burma.

Of these ten undoubted cases of malaria it is evident beyond any reasonable doubt that the disease was transmitted to four at Ketti and in all probability to five of the remaining six.

Furthermore, Dr. K. I. Simon, the Ketti doctor, informs me that he has come across frequent cases of malaria among the Badaga population of the Ketti Valley. Of these numerous cases the possibility of relapses, or of the disease having been contracted elsewhere and having developed in Ketti, can be ruled out in eight instances, as I am assured that these patients never had occasion to leave the Ketti Valley. Blood smears were taken in only four cases but these were all positive for malaria and the remaining cases were all typical and responded to injections and oral administration of quinine.

Details of these eight cases were as follows:—

1940	one case	September.
1941	one case	September.
1942	four cases	April, August, September (2).
1943	two cases	May, August.

<sup>1</sup> This case was infected with both *P. vivax* and *P. falciparum*.

The maximum altitude for the transmission of malaria in these hills was hitherto considered to be 4,000 ft., this being a fairly constant boundary: but here is evidence of transmission at, or above, 6,000 ft.

The weather directly preceding the outbreak of 1941 was extremely wet and without high winds, on account of which the density of Anophelines was high. The older children, among whom the outbreak exclusively occurred, had been practising for their annual sports on the sports ground which is situated at the lowest point of the estate adjacent to the junction of two streams which are bordered at some places by marshy ground. The children had been returning from this field at dusk and it seems probable that the infection was contracted then.<sup>1</sup>

Of the eight above-mentioned village cases six were Badagas who lived close to the stream and the swamps.

Shortly after the outbreak of 1941 painstaking collections of *Anopheles* larvae and imagines were made by Dr. Russell and his staff with the following results:—

Species	Larvae.	Adults.
<i>A. aitheni</i>	43	1
<i>A. culicifacies</i>	nil	1
<i>A. gigus</i>	19	1
<i>A. jeyporensis</i>	9	1
<i>A. maculatus</i>	27	nil
<i>A. splendidus</i>	3	3

All the adults were dissected and found negative.

Owing to unfavourable weather conditions the collections were scanty. *A. culicifacies* is a known carrier on the plains wherever it has sufficient density and is, I believe, a new species at this altitude. *A. fluviatilis*, the common carrier on the ghats, was not observed. None of the others is a known carrier in the Nilgiris, but *A. jeyporensis* has been known to transmit malaria elsewhere.<sup>2</sup>

What then is the cause of this transmission of malaria at an unprecedented altitude? Two solutions are suggested below or a combination of both may solve the problem.

The first is a solution suggested by Dr. Russell.

During 1941 more than 2,000 labourers, many from malarial districts, were imported to Aruvankadu, between two and three miles from Ketti, and it seems possible that with such ample opportunities for infection the local Anophelines may transmit malaria. In this respect it should be noticed that in November of 1941 two cases of malaria were observed among adults in Aruvankadu who had not been out of the village for some years and another case was observed in the neighbouring township of Wellington at 6,000 ft. It is of course quite probable that there have also been other cases in neighbouring villages which have not been reported.

<sup>1</sup> Since the introduction of Summer Time there has been no occasion for children to be near the stream at, or after, dusk and no cases of malaria have been recorded among them.

<sup>2</sup> Bainbrigge Fletcher, *Some South Indian Insects*, 1914.

Whether this solution explains the occurrence of numerous cases in the entirely unconnected valley of Ketti is doubtful but it certainly fails to explain the cases previous to 1941.

The Ketti Valley below the school slopes gradually for  $2\frac{1}{2}$  miles in a southerly direction to Kateri, whence it enters a valley which descends rapidly to the Bhavani Valley at 1,100 ft. The Bhavani River continues in an E. N. Easterly direction to debouch onto the Mettupalaiyam Plain some 9 miles distant. The whole of the lower region is highly malarial.

It is noticeable that the cases of malaria have occurred just before and just after the S.-W. monsoon season when the main wind currents come from the E. and N.-E. respectively. It seems probable that the wind currents strike the entrance of the Bhavani Valley and ascend that and the Ketti stream, reaching Ketti as a southerly breeze. This is certainly my experience of the lower wind currents at these seasons from observations taken near the head of the valley. Such wind currents would doubtless encourage mosquitoes of low elevation habitat, such as *A. culicifacies*, to ascend the valley. At these times of the year they would find the Ketti Valley favourable to mosquito life as it is particularly protected, warm by day and night, and damp and marshy.

What we may term the 'non-malarious seasons' correspond to the S.-W. monsoon season when strong N.-W. (sic) gales blow somewhat against the direction of the valley, the winter, when the nights are cool, and the warm dry period from mid-February to mid-April.

In support of this theory I may state that I have caught certain varieties of butterflies here at those seasons when the upper wind currents flow from the E. and N.-E. whose appearance at the altitude of Ketti is most unusual. The foodstuff of the larvae of some of these species is not found anywhere nearer than several thousand feet lower than Ketti.<sup>1</sup>

It is worth observing that the flora of Ketti is quite normal for the altitude, but this is easily explained by the rough S.-W. monsoon weather and the cool winters.

In conclusion, malaria would seem to be endemic in the Ketti Valley. Is it not possible that the transmission of malaria occurs as a combined result of favourable lower wind currents up the valley at certain seasons, mild wet weather before and after the monsoon, and the protected nature of the valley? When these conditions are combined to an exceptionally favourable degree, as in September of 1941, may we not expect a minor epidemic?

KETTI, NILGIRIS,  
September 10, 1943.

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<sup>1</sup> I have observed the following species of butterflies at Ketti whose appearance at this altitude is most unusual.

*Bindahara phocides moorei*: March.

*Byblia ilithyia*: September.

*Charana jalindra macarita*: early June.

*Nacaduba dana dana*: April.

*Leptosia nina nina*: February.

I have observed no unusual species during the S.-W. monsoon.